POWER SYSTEM MANAGEMENT

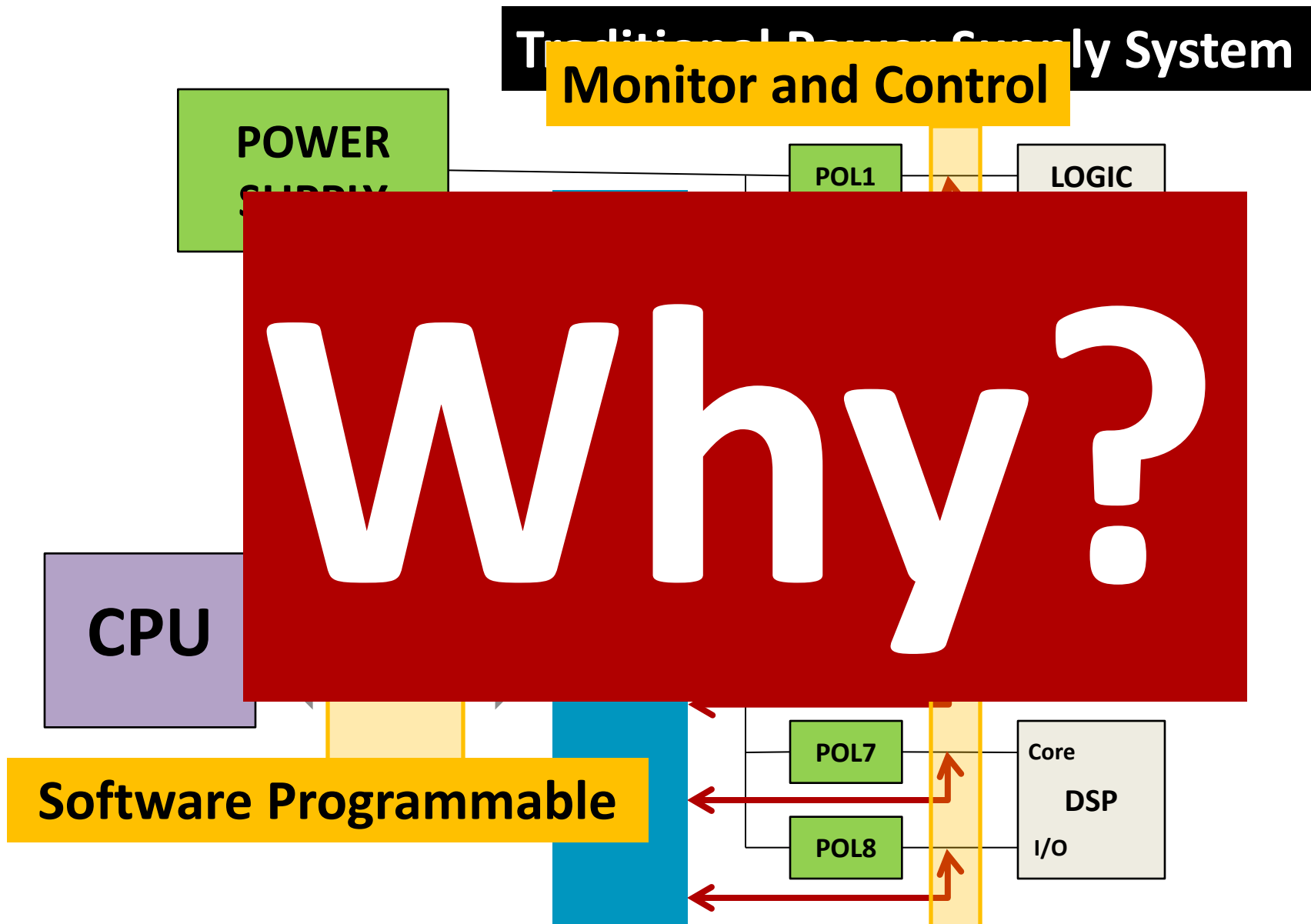Real World Value

Power System Management

- Power
  - Rate at which energy is transferred
- System
  - A set of interacting or interdependent components forming an integrated whole
- Manage
  - To handle or direct with a degree of skill
  - Make and keep compliant

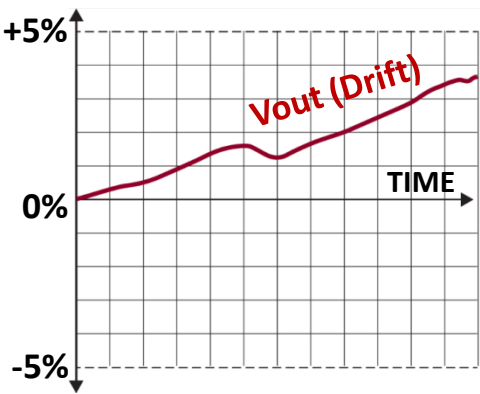# How do you manage a power system ?

- Sequence (turn on)

- Set voltages

- Measure
  - Voltage /Current
  - Power/ Temperature

- Define and manage faults
  - Compare measurements to limits
  - Take action (Turn off)

- Digital interface
  - Configuration (EEPROM)
  - Read-Back

- Fault log (EEPROM)

Basic functions needed to manage a power system

LINEAR TECHNOLOGY

Again...What is Power System Management (PSM) ?

Traditional Power Supply System

Monitor and Control

POWER
SUPPLY

POL1

LOGIC

CPU

POL7

Core

DSP

POL8

I/O

Software Programmable

Why?

Traditional Power Supply

PSM with LTpowerPlay™

Vout (Drift) / TIME / +5% / 0% / -5%

Voltage Optimization

POL 1 ⟷ POL 1

+5% / Performance Optimized / +/- 0.25% / 0% / +/- 0.25% / Vout (Corrected) / Power Optimized / +/- 0.25% / Trim DAC / -5%

Board or BOM change required to adjust voltage

Dynamic Voltage Control

POL 2 ⟷ POL 2

DVFS
FPGA/DSP/ASIC
1.50V / 1Ghz
1.15V / .6Ghz

NORMAL / ECON

System Monitoring

POL 3 ⟷ POL 3

Status and Fault Monitoring

OV/UV/OC Faults with no other system information

PMBus

Power In and Power Out

OV/UV/OC Faults

0 20 40 60 80 100 120 / C / TAYLOR

Correlate Faults to System Status (Predict Failure) and "Black Box" Analysis

Traditional Power Supply | PSM with LTpowerPlay™

Discrete Components

Changes may require board to be reworked

Sequence / Margin / Track

POL 1 ↔ **POL 1**

Software Configurable

Unlimited changes by software

Probes and meters...GOOD LUCK!

Debugging & Troubleshooting

POL 2 ↔ **POL 2**

Status of all POLs can be viewed in software

Margin Supplies to Test System Robustness

POL 3 ↔ **POL 3**

Can't be easily done Accuracy is poor

PMBus

Test system performance with different combinations of voltages

Typical design that needs Power System Management

- 8-50 power rails

- Fast design time

- Tight power supply tolerances

- Lots of power supply parameters determined empirically
  - Power supply voltage levels
  - Sequencing arrangement
  - Power supply ramp rates
  - OV/UV/OC supervisor levels
  - Fault management behavior
  - Margin test levels
 - Monitor warning levels

Keys Benefits of PSM

- **Reduce Design Cycle Time**
  - Software configurable power supply eliminates board rework
  - Fault logging reduces debug time
- **Field updates solve problems quickly**
  - ASIC update may require different VDD and sequencing
  - Overcoming brown-out during product qualification can save months
- **Improves performance**
  - ASIC binning
  - Voltage Scaling
  - Reliability
- **Your <u>competitor</u> will be using it!**

LINEAR TECHNOLOGY

Is this stuff complicated?

- **No!**

- **Individual functions are simple**

- **LTC devices are autonomous**
  - Provides functionality without any software

- **LTpowerPlay™**
  - Easy to use GUI
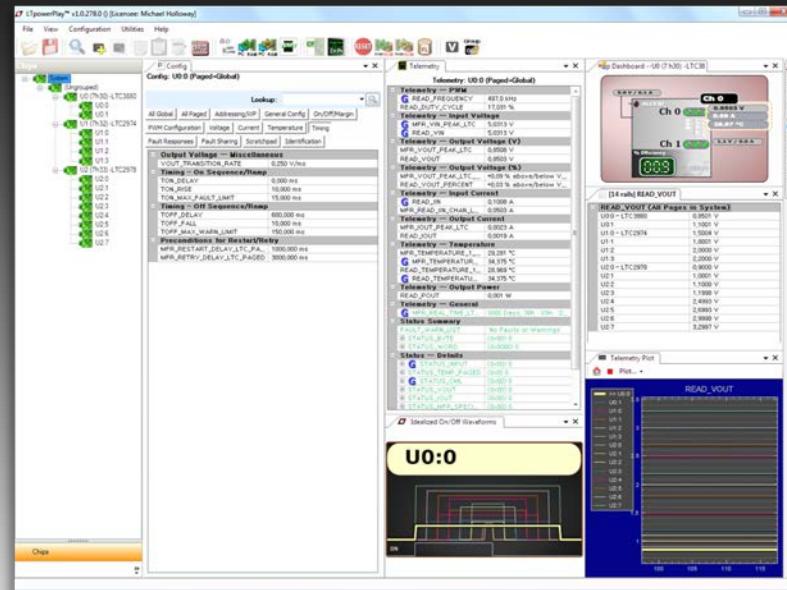
Is Power System Management new?

- ## No
  - This has been around for years
  - Improved reliability of early computers

- ## It is now essential
  - Supply tolerances are very tight (<2%)
  - Systems are more complex
  - Time to market is critical

- ## Present in all modern systems
  - Typically not highly integrated
  - Typically not software programmable
  - LTC offering IS programmable and highly integrated

LINEAR TECHNOLOGY

Who drove the development of modern PSM?

- ## End Users: Big Data Centers
  - Power usage is a huge cost factor
  - Reliability and Uptime is critical

- ## Early Adopters: Network Server OEMs
  - Optimize compute cycle per Watt
  - Dynamically manage the power supply
  - Lower the cost of ownership

- ## Other equipment segments have followed
  - Communication Infrastructure
  - Instrumentation
  - ATE
  - Military
  - Industrial

What problems will PSM solve today?

- **Modern designs have many voltage rails**
  - Sequence arrangement is complex
  - System level fault detection and management is needed
- **FPGA/ASIC need high performance power supplies**
  - Fast transient response
  - High accuracy (< 2%)
  - Lots of separate but inter-related POLs
- **System power consumption and thermals are too high**
  - Manage supplies to meet energy consumption and thermal targets
  - Need to accurately measure voltage, current and temperature

What problems will PSM solve today? (Part 2)

- **High Reliability and Quality**
  - Margin testing
  - Correlate failure with Voltage, Current and Temp measurement
  - BIST
  - Remote debug
- **Design schedules are compressed**
  - Final power supply requirements not known until very late
  - No time for board spins or BOM changes
  - Features need to be programmable with software

LTC PSM Value Proposition

- ## Complete Solutions!
  - Monitor, Margin, Supervise, Sequence, Fault Manage and Log
    - 2/4/8/12/16 channel solutions
  - DC/DC converters with PSM built-in
  - Complete programmable power supply in BGA package

- ## Best Specs!
  - DC accuracy and regulation
  - Transient Response
  - Multi-Phase Current Sharing Accuracy
  - Input/Output Voltage & Current Measurement
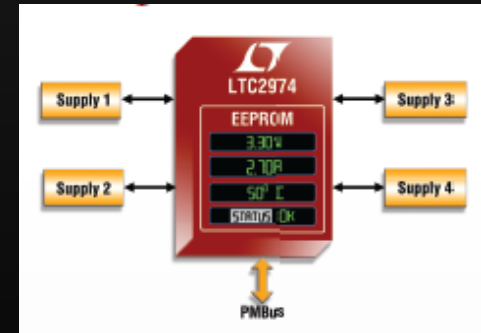
- ## Best Design Tools and Support!
  - LTpowerPlay, LTSpice

- ## Highest Reliability!

LINEAR TECHNOLOGY

Power System Management Product Lineup

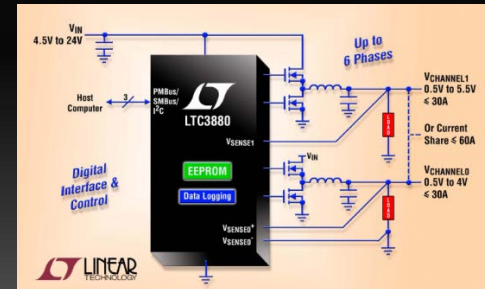- ## Power System Managers
  - Add Power System Management to any power supply
    - LTC2970: 2 CH Power System Manager
    - LTC2977/78: 8 CH Power System Manager with EEPROM
    - LTC2974: 4 CH Power System Manager with EEPROM

- ## DC/DC Converters
  - Analog Control Loop plus Power System Management
    - LTC3880: Dual Output Poly-Phase Current Mode DC/DC
    - LTC3883: Poly-Phase Current Mode DC/DC

- ## uModules
  - Complete 26A Programmable Power Supply
    - LTM4676 (Dual 13A Output) in 16mmx16mm BGA
      - Includes Inductors and Power Stages

LTC2978/77, LTC2974 Feature Summary

- **Monitor**
  - Voltage, Current and Temperature
- **Margin/Trim**
  - Closed loop servo to 0.25% accuracy
- **Sequence Rails**
  - Time and Event Based
- **Voltage Supervisor**
  - Fast dedicated OV/UV comparators
- **Current Supervisor**
  - Fast OC response (LTC2974)
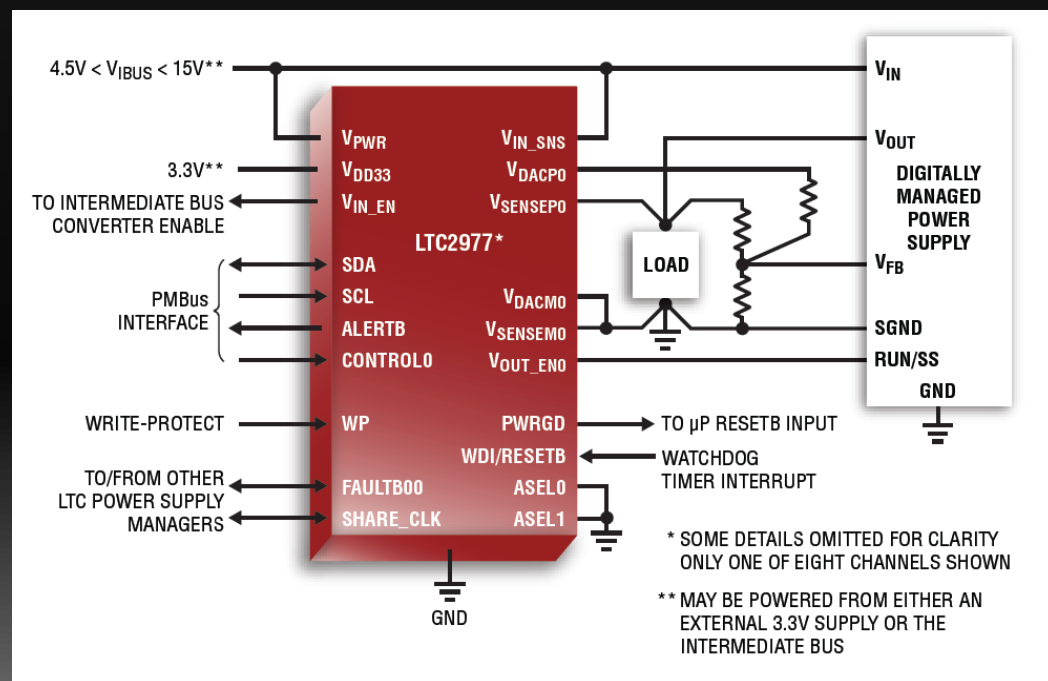- **Fault Management**
- **Fault Log**
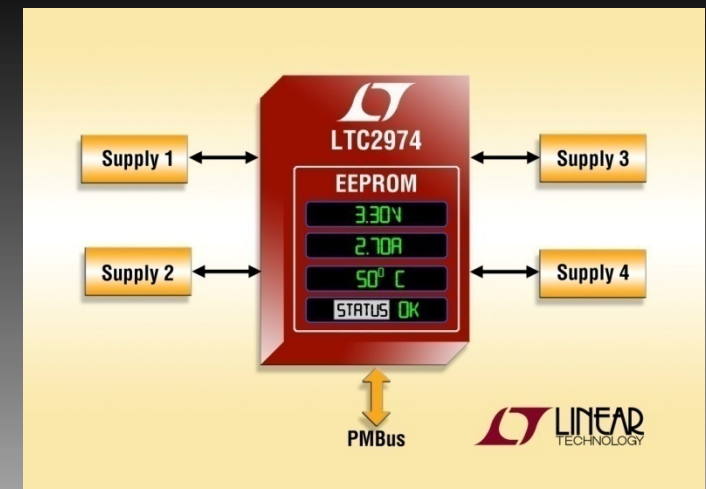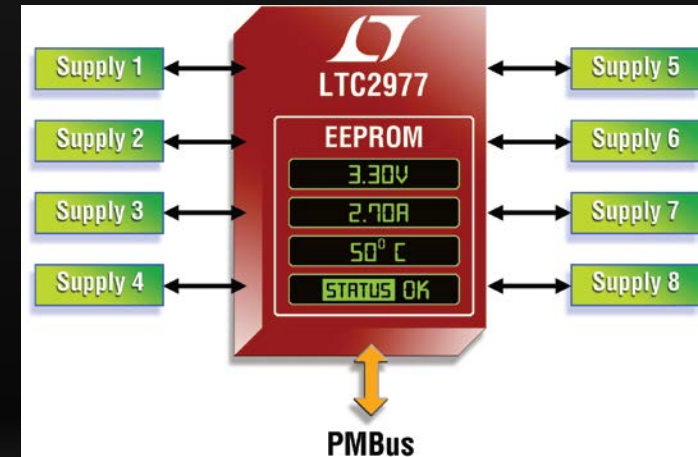
LTC2978/77: 8-Channel Power System Manager Featuring Accurate Output Voltage Measurement
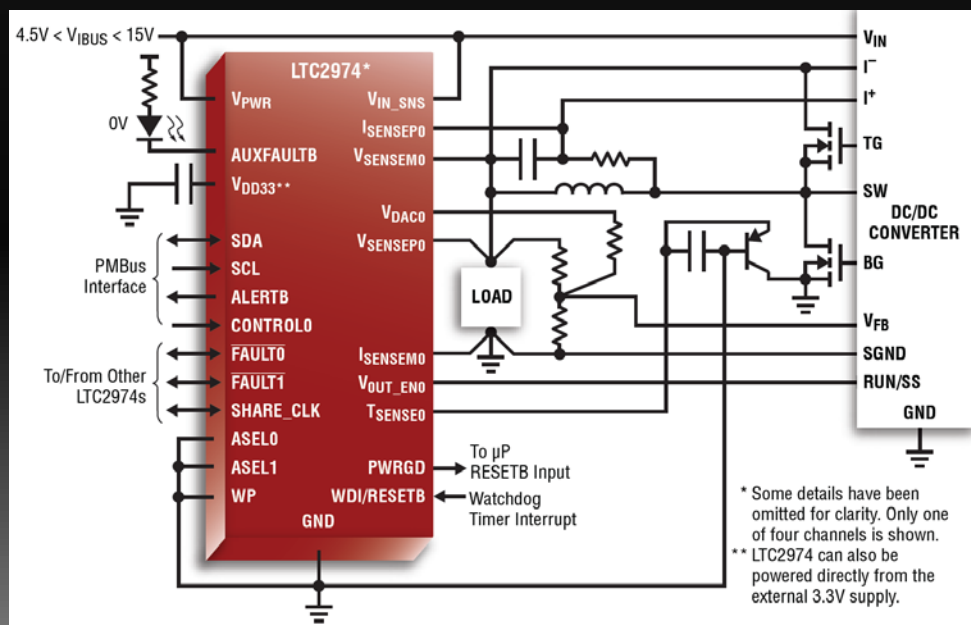
Key Features

- **16-bit ADC Monitor**
  - Output Voltage
  - Input Voltage
  - Internal Temp
- **10-bit Margin DAC**
  - Margin and Trim
  - Less than 0.25% error
- **Time Based Sequencing**
- **Prog OV/UV Supervisors**
  - Input Voltage
  - Output Voltage
- **Cascadable Fault Management**
- Fault Log
- 9X9 64-pin QFN

4.5V < V$_{IBUS}$ < 15V**

3.3V**

TO INTERMEDIATE BUS CONVERTER ENABLE

PMBus INTERFACE

WRITE-PROTECT

TO/FROM OTHER LTC POWER SUPPLY MANAGERS

LTC2977*

V$_{PWR}$
V$_{DD33}$
V$_{IN\_EN}$
SDA
SCL
ALERTB
CONTROL0
WP
FAULTB00
SHARE_CLK
GND

V$_{IN\_SNS}$
V$_{DACP0}$
V$_{SENSEP0}$
V$_{DACM0}$
V$_{SENSEM0}$
V$_{OUT\_EN0}$
PWRGD
WDI/RESETB
ASEL0
ASEL1

LOAD

TO µP RESETB INPUT
WATCHDOG TIMER INTERRUPT

V$_{IN}$
V$_{OUT}$
DIGITALLY MANAGED POWER SUPPLY
V$_{FB}$
SGND
RUN/SS
GND

* SOME DETAILS OMITTED FOR CLARITY ONLY ONE OF EIGHT CHANNELS SHOWN

** MAY BE POWERED FROM EITHER AN EXTERNAL 3.3V SUPPLY OR THE INTERMEDIATE BUS

LINEAR TECHNOLOGY

LTC2974: 4-Channel Power System Manager Featuring Accurate Output Current Measurement
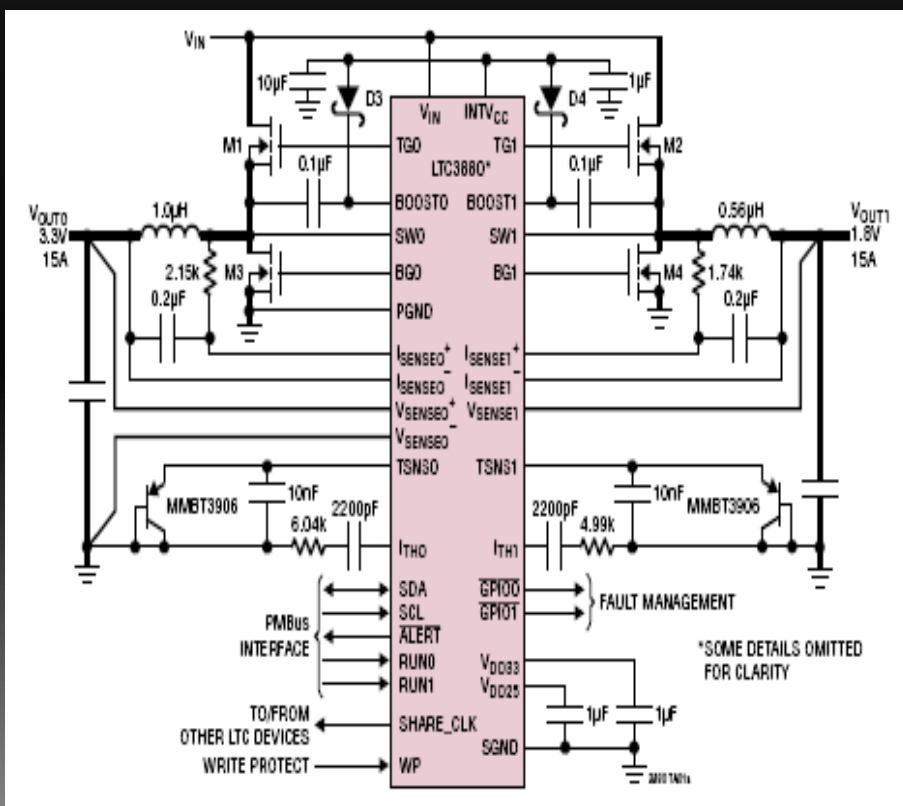
Key Features

- **16-bit ADC Monitor**
  - Output Voltage and Current
  - External Temp
  - Input Voltage
  - Internal Temp
- **10-bit Margin DAC**
  - Margin and Trim
  - Less than 0.25% error
- **Time & Event Based Sequencing**
- **Prog OV/UV/OC Supervisors**
  - Input Voltage
  - Output Voltage
  - Output Current
- **Cascadable Fault Management**
- Fault Log
- 9X9 64-pin QFN

LTC3880: Dual Output, Current-Mode Step-Down DC/DC Controller with Power System Management
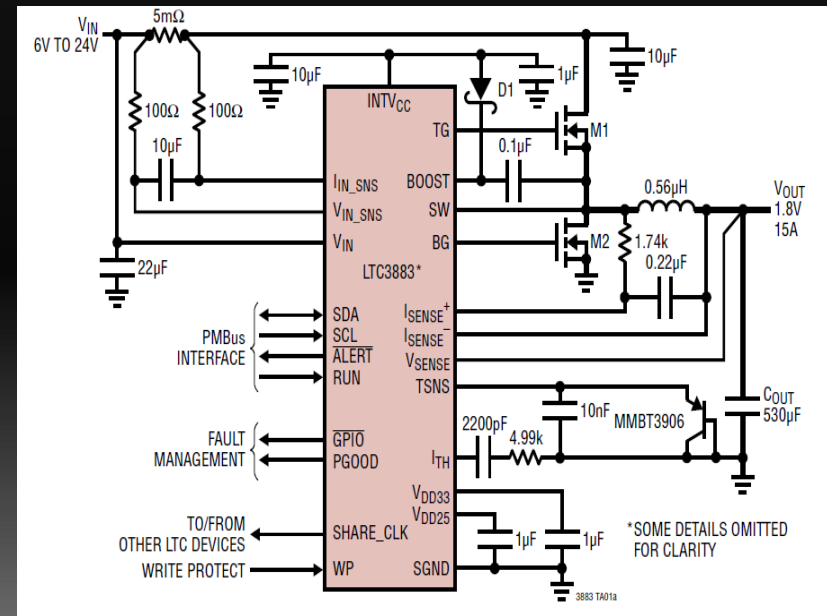
Key Features

- **2 Independent Channels**
- **Integrated Gate Drivers**
- Wide Input Range: 4.5V to 24V
- 12-bit V_{OUT} Programming up to 5.5V with ±0.5% Accuracy
- 16-bit A/D Monitor of V_{IN}, V_{OUT}, I_{OUT}, Temperature, Duty Cycle
- Programmable UV/OV/OC Supervisors
- Support for Sequencing, Tracking and Poly-Phase Operation
- Fault Logging
- 40 pin (6mm x 6mm) QFN Package

LTC3883 Single Phase Step-Down Current-Mode DC/DC Controller with Power System Management

Key Features

- **Input Current Sense Amp**
- **Inductor DCR measurement**
- **Integrated gate drivers**
- Wide Input Range: 4.5V to 24V
- 12-bit V_{OUT} Programming up to 5.5V with ±0.5% Accuracy
- 16-bit A/D Monitor of V_{IN}, V_{OUT}, I_{OUT}, I_{IN}, Temperature, Duty Cycle
- Soft-Start/Stop, Sequencing, Margining, and Poly-Phase Operation
- Internal, External Temperature Monitors
- Fault Logging
- Programmable UV/OV/OC Supervisors
- **5X5 32-pin QFN**

LTM4676: Dual-13A uModule Regulator with Power System Management

Key Features

- **Complete Dual 13A DC/DC converter**
  - **Includes inductors and power stage**
  - **Parallel outputs for 26A supply**
- **Features (derived from LTC3880)**
  - Wide Input Range: 4.5V to 24V
  - 12-bit V_{OUT} Programming up to 5.5V with $\pm$1% Accuracy
  - 16-bit A/D Monitor of V_{IN}, V_{OUT}, I_{OUT}, I_{IN}, Temperature, Duty Cycle
  - **High accuracy I_{OUT}, I_{IN} measurement**
  - Soft-Start/Stop, Sequencing, Margining, and Poly-Phase Operation
  - Internal, External Temperature Monitors
  - Fault Logging
  - Programmable UV/OV/OC Supervisors
  - **16mm x 16mm x 5.01mm BGA**
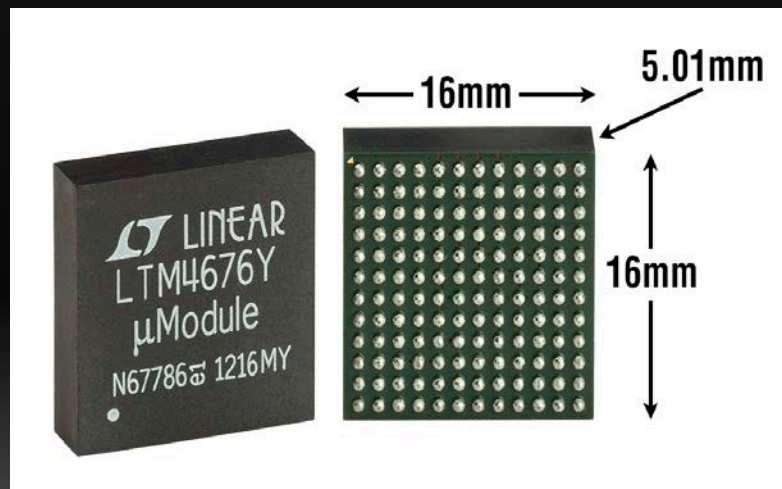
LTC Power System Management
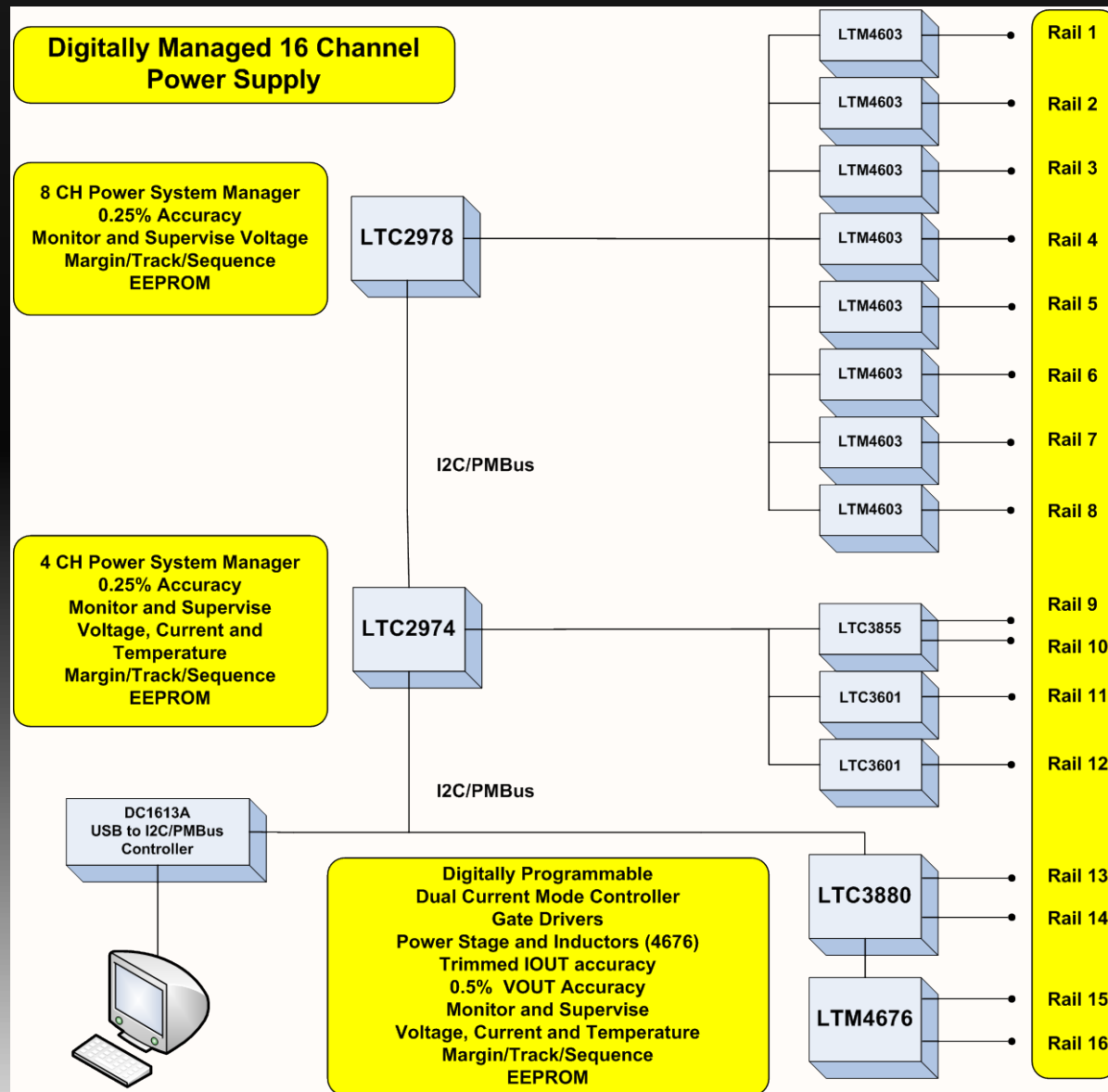
- **<u>For More Information:</u>**

- **<u>Existing Arrow Customers: 800 777 2776</u>**

- **<u>New Customers: 800 833 3557</u>**
  <u>www.arrownac.com/powermanagement</u>